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MANAGEMENT
AND
AUTOMATIC DATA PROCESSING SYSTEMS

By

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April, 1960

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Prepared for Dr. A. Rex Johnson

PREFACE

The glamor of Automatic Data Processing Systems has become somewhat tarnished because of the failure of businesses and government to achieve the envisioned savings.

In the preparation of this paper the writer has attempted to determine what benefits have accrued through the use of ADPS, what are its shortcomings, and how can it be improved.

The report is tailored to management of systems as a whole, rather than to specific activities or applications.

Some references to activities within the Department of Defense are not identified. The main objective was to identify problems rather than the activity.

Acknowledgment is made to the personnel of the Office of the Assistant Secretary of Defense (Comptroller) and, in particular, Mr. W. H. Gammon for making files and technical information available.

F.L.S.

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CHAPTER I

INTRODUCTION

Background

Electronic computers are undoubtedly the most complex and expensive business tools ever devised, but a surprising number of companies are finding that they cannot afford to be without them.[1] With the increase in size, number, and scope of businesses today, the development of computers was almost a necessity.

The profound effect that computers will play in this new industrial revolution has been very aptly described by Ralph J. Cordiner, Chairman, General Electric Company:

> When the history of our age is written, I think it will record three profoundly important technological developments:
> Nuclear energy, which tremendously increases the amount of energy available to do the world's work;
> Automation, which greatly increases man's ability to use tools;
> And computers, which multiply man's ability to do mental work.
> Some of our engineers believe that of these three, the computer will bring the greatest benefit to man.[2]

In this report the writer has attempted to determine the progress made in the field of ADPS and, in particular, the progress made in the Department of Defense. A review of the advantages and disadvantages of ADPS is made in Chapter II. In Chapter III the results of some of the past

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[1] William Harris, "The Astonishing Computers," Fortune, June, 1957, p. 136.

[2] "A Business Week Special Report on Computers," Business Week, June 21, 1958, p. 3.

performances and pitfalls of ADPS are discussed. The role of management in ADPS is covered in Chapter IV. Chapter V contains the conclusions, recommendations, and a look into the future.

Scope

Fifteen agencies in the executive branch of the government are using ADPS either on a rental basis or they have purchased computers. Several major fields of endeavor have been applied to ADPS:

1. Business management, involving digital computer systems primarily
2. Science and engineering, involving analog computer systems primarily; however, digital computers may also be used
3. General purposes, where the fields mentioned in 1 and 2 above are combined, usually in civilian agencies
4. Intelligence operations
5. Military operations, involving the use of all kinds and sizes of computer systems for purposes not covered in 1 through 4 preceding.[3]

Some authorities on ADPS indicate that digital rather than analog computers are more widely used in science and engineering fields.

There is no over-all government program for ADPS, but the President's Management Improvement Plan Project recommended that the Bureau of the Budget take a more active role. The report proposed that the Bureau of the Budget, with the advice and assistance of agencies, should assert broad, general leadership and coordination of the ADP program in the executive branch. This would involve government-wide responsibility for the following:

1. Insuring effective internal and government-wide coordination of the ADP program with related programs and activities
2. Formulating and Promulgating policy, criteria and planning guidance for the ADP program of the government.

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[3]A President's Management Improvement Fund Project, conducted under the direction of the Bureau of the Budget, A Report of Findings Resulting From the Automatic Data Processing Responsibilities Study, Sept. 1958 to June 1959, p. 2

3. Planning and coordinating the implementation of government-wide ADP orientation and training

4. Establishing government-wide formulas for costing ADP applications and reviewing and analyzing summary cost data in terms of dollars and of manpower utilization

5. Fostering, promoting, and coordinating the interagency sharing of ADP equipment

6. Developing specific plans for an experimental computer service center and, if deemed feasible, taking action to assure the creation and operation of the same

7. Coordinating research and development programs of the government

8. Providing leadership in a government-wide effort to alleviate the problems of incompatability of equipment

9. Fostering and promoting studies which will lead to minimizing the vulnerability of ADP equipment to sabotage, enemy attack or natural disaster

10. Operating a government-wide Information Exchange

11. Sponsoring the continuation of the Interagency Committee on ADP and assuring its effective utilization

12. Reviewing and assessing progress of ADP Programs in selected agencies and for the government as a whole.

13. Fostering and promoting desirable standardization in ADP systems which are common to all agencies

14. Using existing information sources and obtaining such additional summary information as may be essential to the effective performance of the responsibility assigned.[4]

As early as 1955 Congress held hearings on Automation. These hearings pointed out the close relation between computers which control mechanical processes and those designed primarily to handle data processing.

The General Accounting Office has prepared a very thorough report to the Congress on the trend of development and use of ADPS in business and management control systems. This report stressed the need for a more coordinated effort of government-wide programs in ADPS. Also, the report indicated that the following trends are developing within ADPS:

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[4] Ibid., p. 4.

1. More centralized processing of data

2. Consolidation of related data, previously contained in a series of reports, into a consolidated report

3. Consolidation of related files into one file

4. Preparation of more meaningful management reports

5. Development of needed management reports which were not feasible under conventional systems

6. Reduction in the time cycle required for the processing of data and report preparation.[5]

The Bureau of the Budget and the General Accounting Office may take a more active part in the government-wide operation of ADPS in the future. One aspect, which they will undoubtedly consider, is the overall savings or increased costs of operation since conversion to ADPS.

The scope of this report will be limited to the utilization of ADPS for business applications. This is the area where the government appears to have the greatest potential for achieving savings in personnel.

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[5]A Special Report to the Congress of the U. S. Survey of Progress and Trend of Development and Use of Automatic Data Processing in Business and Management Control Systems of the Federal Government, June, 1958, p. 14

CHAPTER II

AUTOMATIC DATA PROCESSING SYSTEMS

Advantages

The advantages of Automatic Data Processing Systems have been emphasized for many years, but it is desirable to mention a few of the major advantages here. An important fact to remember is that computers have limited use, and their use should be limited to those areas where the advantages of ADPS can be realized. (See page 7 for limitations)

The major advantages of ADPS are:

1. Speed
2. Accuracy
3. Automatic decision making
4. Permits management by exception technique
5. Saves office space
6. Greater flexibility
7. Raises the level of work in the office

The speed of the computers has been proved beyond doubt. Management has been able to receive more timely reports upon which to base decisions.

Accuracy is another feature of ADPS which is great importance. Some mistakes which were made during the early programming of the machines have been highlighted out of proportion because of the ridiculous errors contained in the print out of the final results. The point to remember is that once the program is completely check out there is very little chance for error. Most machines have internal checking features which permit the machine to check on itself.

The decision-making capability of ADPS is one of the most important benefits to be derived from its use; however, this feature is rarely used to its maximum potential. The arithmetic and logical units of the computer accomplish this function based on the instructions contained in the internally stored program of the computer. In using the computer for this purpose the decisions are made before the fact; and it permits consistent decisions to be made every time. Also, these decisions can be the ideas of the best man qualified to make them, rather than many persons making different decisions with the same criteria.

Management by exception technique can be applied with confidence through the use of ADPS. In the past, there has been some reluctance on the part of management to utilize fully this technique for fear that subordinates would withhold vital information if it affected them personally. The computer can be programmed to make decisions within certain limits and take automatic action within these prescribed limits. This action can be taken without referring the problem to any office worker or any member of management. Once the strict guidelines have been exceeded and the problem is no longer within the established limits, the problem is referred to someone for action. This can be in a form of a card or printed document. The important fact is that management will get into the picture only when a problem exists which requires its attention. This is management by exception with controls.

The installation of ADPS usually saves valuable office space by replacing bulky file cabinets, card cabinets, EAM machines and, in some cases personnel. Working conditions are also improved. The air conditioning required for the computer and its peripheral equipment provides ideal conditions for the personnel working in these spaces.

Flexibility is another advantage of ADPS, but flexibility is limited. The computer is flexible in that it can perform many functions at the same

time and can combine many reports into one. Next, it may come out with a summary of the results. Unfortunately many people forget about the limitations and become disturbed when they are told that it may take two or three months to get something out of the machine because the information must be programmed, which takes an inordinate amount of time. There is no substitute for good planning when working with computers.

ADPS can raise the level of work in the office. The monotony of many jobs can be eliminated and the people can be given more interesting and important jobs. Those people who do get better and more interesting jobs because of this change have improved morale and become motivated to strive for greater achievement.

Disadvantages

The advantages of ADPS are well known, but rarely are the disadvantages discussed. Perhaps these disadvantages could more appropriately be called limitations. The limiting factors or disadvantages must be recognized and planned for in every installation. The most important of these disadvantages are:

1. High cost of installing and operating the ADPS
2. Excessive time required in the analysis and programming of an application
3. Excessive time required in training programmers and operating personnel
4. May cause extensive reorganization, which is usually met with considerable resistance
5. May cause a rewrite of all important operating procedures of applications placed on ADPS
6. Requires training of management at all levels on how to use the computer efficiently

7. Causes a morale problem for those people who are adversely affected by the installation of ADPS.

The cost of installing and operating ADPS is of utmost importance. For example, for a large-scale computer the average start-up costs are $800,000, and the average operating costs are $750,000 a year.[6] These figures are based on rental of the equipment since most computers are rented. Each addition of information or requirement for a report adds to the cost of operation. The value of each report to management must be weighed against the cost to obtain the information.

The length of time required in the analysis and programming of an application varies considerably with the complexity of the job. The initial programming and testing of the application usually consumes the most time. The analysis of a job requires very detailed planning, which management is not accustomed to performing. Programming requires a more detailed and precise flow chart of the job than does analysis. Both of these tasks combined consume more time than management can afford without some assurance of money-saving results.

Training of personnel in programming and operating the computer, on the average, requires from three to six months, depending on the size and type of computer. The formal technical training in programming furnished by the manufacturer usually requires about one month of this period. After the formal training, the programmer usually becomes proficient in his job by performing on-the-job training which consists primarily of writing programs.

The installation of any large and sometimes even medium scale computers requires applications of great magnitude to effectively defray the costs of installing and operating the equipment. These applications usually constitute the major work effort of the office, and frequently they cut

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[6] "A Business Week Special Report on Computers," Business Week, June 21, 1958, p. 6.

across organizational lines. Once these applications are placed on a computer it becomes necessary to reorganize or realign the remaining manual work effort. There is usually considerable resistance to change.

Although there are many computers installed today, only a few companies or government activities have experienced the success envisioned. Most companies and government activities have experienced an increase in over-all costs as a result of installing computers. Management must be trained on how to use the computer efficiently and effectively.

When a computer is installed, the people welcome it with mixed emotions. They are usually for the installation of the computer as long as it does not affect them personally. Some reduction of personnel generally takes place, which naturally has an adverse effect on the morale. The person who feels that he will lose his job or his status will not cooperate in making the computer installation a success.

CHAPTER III

ANALYSIS OF AUTOMATIC DATA PROCESSING SYSTEMS

Past Performance

The threshold of Automatic Data Processing Systems has passed, but efficient use of these machines must be left to the challange of the future. The real potential of these machines has been snagged in false starts and mistakes in use -- but they are on their way.[7]

Judging the past performance of ADPS is very difficult and sometimes misleading. If computers are installed in order to accomplish a foreseeable increase in workload, there may not be an over-all monetary savings in the operation of the office. Also, the intangible benefits realized through the use of ADPS may be far more important than the direct tangible benefits. The measuring of an activity's performance strictly by monetary savings can be misleading, because an inefficient activity should incur a greater savings by conversion to ADPS than a highly efficient organization.

Some companies have purchased computers merely for prestige; who can say that the computer is not paying for itself if the company can recover its expenditure by capitalizing on the computer through favorable advertisements? Computers purchased for this purpose are in the minority. Some companies have advanced to the point whereby they have developed an automatic system of inventory control without human review.

One of the leading EDPM consulting firms has made a survey of computer users and published the results in a report. One of the exhibits gives an indication of past performance, Table 1.

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[7] Ibid., p. 3.

TABLE 1

DID COMPUTER LIVE UP TO EXPECTATIONS IN SPECIFIC AREAS[a]

Area	Yes	No
Clerical savings	66%	34%
Improved procedures	98%	2%
New facts for short-range decisions	63%	37%
Reports prepared faster	81%	19%
New facts for long-range decisions	66%	34%
Peak loads reduced	59%	41%
New analyses of existing data	90%	10%
Greater accuracy	94%	6%
Improved employee morale	53%	47%
Upgrading of personnel	70%	30%
Data not economically feasible hitherto	89%	11%

[a]A Survey of Current Practice, John Diebold and Associates, Inc., Management Consultants, 1959, p. 18

Table 1 indicates that computers have fallen short of expectations. Accuracy and improved procedures are two areas where the computer has almost lived up to its advance billing. Another important point, which is highlighted here, is that the area of morale was farthest away from the expected results. Also, according to this survey, the computer has failed to do much about the reduction of peak loads.

The Department of Defense, which is the largest user of ADPS, has had some success with ADPS but not to the degree expected. The review process which has been issued by OSD is so thorough and detailed that it should insure a higher degree of efficiency than is experienced in industry. Detailed instructions concerning the Data Processing Program have been issued by the Secretary of the Navy for naval activities.[8] These instructions are the implementation of the guidelines furnished by OSD. Each bureau has issued its own instructions on the program.

[8]SECNAV INSTRUCTION P-10462.7, Data Processing in Navy Management Information Systems, 16 April 1959

After a feasibility study has been made and a justification for a machine prepared by an activity in the Navy, the review process begins. First there is the bureau review; then a copy is furnished to the Office of Naval Material and to the Navy Management Office for their review; next, the justification report is forwarded to OSD. When OSD approval is granted there is still the OSD on-site readiness review which takes place prior to arrival of the equipment. On this review, representatives of OSD are accompanied by representatives of the Navy Management Office, and the appropriate bureau. This is the final test to insure that the activity is ready to utilize the computer on its arrival.

The Navy cannot install an ADPS for application to business administration, logistical, and record keeping procedures without OSD approval. Present and proposed ADP installations must be identified, as to purpose, in one or more of the following justification categories:

1. To reduce current direct costs
2. To prevent major direct increases in direct costs
3. To solve a major processing deficiency
4. To conduct experiments in design of ADPS[9]

Installation of most machines has been justified on the basis of some direct savings, although justification may include increase in workload as well. The OSD, with representatives of the appropriate military department and bureau, conducts a performance evaluation of each activity under OSD which has had an ADPS installed for at least a year. The results of these surveys are shown in Table 2.

The OSD evaluation reports clearly indicate that activities which have installed ADPS have not realized their expected savings. There are many reasons why the savings have not materialized; however, there should be

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[9]Ibid., p. III-1.

TABLE 2

SUMMARY OF DOD EVALUATION REPORTS

Activity	Annual ADPS Cost Est.	Annual ADPS Cost Actual	Personnel Saved Est.	Personnel Saved Actual
A	$ 405,300.	$ 599,184.	135	93
B	1,812,000.	1,662,000.	100	35
C	258,000.	635,000.	40	19
D	a	855,000.	124	82
E	732,000.	1,392,000.	172	161
F	468,800.	1,708,300.	156	150
G	788,110.	845,000.	78	64

[a]Not indicated in evaluation report

a more accurate way to estimate the savings, or to estimate the increased costs. The primary reasons given for failure to meet the anticipated savings are:

1. Increase in assigned workload
2. Change in operating procedures
3. Change in mission with additional duties assigned
4. Pay raises for military and civilian workers
5. Programming the computer took more time and was more expensive than anticipated
6. Program testing and "debugging" took more time and was more expensive than anticipated

The OSD evaluation reports have contained some very pertinent recommendations. Some of the more important are:

1. Top management should develop a systems-wide approach
2. Excessive print outs of information are made

3. The services should study procedures for the most efficient and effective method
4. Eliminate unnecessary manual review
5. A review and follow-up should be made to determine the usefulness and continued need of all computer products

These recommendations seem to indicate that even though there has been some justification for failure to realize the envisioned savings, there is much room for improvement in the operation of ADPS.

The activities under the OSD have identified certain benefits from ADPS, the most important of which are:

1. A one-time savings in inventory and storage costs
2. Greater accuracy
3. Greater speed in accomplishing assigned tasks
4. Improved support to the operating forces through improved allowance lists and better inventory control procedures
5. Improved management reports
6. Some savings in personnel[10]

A survey made of ADPS users in industry revealed the following benefits were realized:

1. Increased speed
2. Reduction of errors
3. Development of management information
4. Reduction of costs[11]

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[10] Evaluation Report on ADPS, DOD reports.

[11] A Survey of Current Practice, John Diebold and Associates, Inc., Management Consultants, 1959, p. 19.

Pitfalls

Certain areas have been pinpointed as problem areas in the installation and operation of ADPS. By careful consideration of the problem and by proper attention of management, most of these pitfalls can be avoided.

1. Concentrating on the hardware instead of the system.[12] Too often companies focus their attention on the technical capabilities of a particular system, rather than on their ability to use it. The system must be fully developed before a machine is selected.
2. The important decisions have sometimes been delegated to technicians rather than dealt with as managerial problems.
3. Failure to organize concurrently with the installation of ADPS.
4. Failure to use a system approach--Some applications placed on ADPS are merely the manual system mechanized. This approach may even increase the over-all cost of operation of the company.
5. The step-by-step approach--This approach is easier but very costly. ADP operates most efficiently as an integrated system. The step-by-step approach merely delays the ultimate objective of an integrated system.
6. Unprofitable applications--Some applications have been placed on ADP which can more economically be accomplished by manual or EAM methods.
7. Lack of participation by management.

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[12] Pitfalls to Business Data Processing, John Diebold and Associates, Inc., Management Consultants, 1957, p. 2.

CHAPTER IV

THE ROLE OF MANAGEMENT IN ADPS

Responsibility

Management is the key to efficient and effective utilization of ADPS. Sometimes the job of preparing for the installation of a computer is turned over to a committee, with meagre or no guidelines. With this type of arrangement the committee must make decisions that should be made by management. Later, these decisions may be met with resistance by the operating people or by management and may cause considerable confusion or delay to the program.

The installation and operation of an ADPS is first a management problem, then a technical one. Too often the job is considered primarily a technical responsibility. The technician is important, of course, but making management decisions is not his responsibility.

Management improvement or advancement has not kept pace with the technological advancement in computers.[13] ADPS requires a change in the thinking process. Management must think in terms of a system—not in terms of an individual application or report. Also, if there is a need to improve management, we should study management rather than computers.[14]

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[13] Donald Malcolm, Director, Systems Development Corporation, Lecture before Navy Comptrollership Course, The George Washington University, 29 Feb. 1960.

[14] E. D. Dwyer, "The Computer Challenge," Navy Management Review, August, 1959, p. 3.

Planning for ADPS requires a change in the planning process. In the past operational planning has been accomplished on a short-term basis. In fact, in some cases it has been reduced to a "fire drill" basis. When an application is being planned for ADPS, management decisions must be made which will apply twelve to eighteen months in the future. Not only must these decisions be made far in advance, but also they must be made in minute detail.

Organization

The effect that ADPS will have on the organization is another management problem which cannot be dealt with lightly. The problems of organization are twofold:

1. Where should the computer be in the organization?
2. What is the effect of the computer on the entire organization structure?

The obvious answer to the first question is that the computer should be placed where it can be operated most effectively. The elements which make up an ADPS organization are:

1. Systems development. This group determines which applications are appropriate for ADP processing, integrates the applications into a system, and prepares a general flow chart and other technical information for the programmer.
2. Programming. This group usually receives the information concerning a program through the systems development analyst. The programmer prepares a very detailed flow chart of the program, converts the program to machine language, tests and "debugs" the program, and provides operating instructions to the operations personnel, once the program is completed.

3. Operations. This group operates the computer, EAM equipment, and other paper handling and key punch equipment. It also maintains the tape library and other peripheral ADP equipment.

In some activities the three elements mentioned above are combined into one organizational unit, sometimes called a "Data Processing Division." This provides a homogeneous and efficient group from a technical standpoint. The problem with this type of organization is its relationship with the entire organization. Should this group be a service organization? If so, then the management personnel, who know most about how to use the computer effectively, are subservient to a less-informed group. The other possibility is to give this group over-all authority concerning the applications on or considered for ADP. This would certainly provide the most efficient operation of the computer, but the group may not have a broad enough outlook of the over-all operation of the office.

Other activities have separated the systems development responsibility from the Data Processing Division. In other words, this separates the analysts from the programmers and the operators. On the surface this appears to have considerable merit. The analysts are placed in the planning group within an organization where they can exercise their potential. The disadvantage of this type of arrangement is that, if the analysts become too engrossed in the planning phase, they may neglect the technical aspect of the program. This would require that the programmers do more of the analytical phase of the problem than those programmers in the first type of organization. The close association required between the analyst and the programmer has become separated by divisional walls.

Another type of organizational structure would be to place both the analysts and programmers in the planning group. The operations group would

then be a service organization. This type of organization would have all the advantages of the second organization without the disadvantages. Some people feel that this organization would place too many people in the planning group, but others feel that the size of the group is not important.

The effect of ADPS on the organization depends on the scope of the applications. For example, if the computer is used for an inventory control application only, the computer should operate under and be the responsibility of the inventory control department. There is no need to upset the entire organization structure if only one group is affected by the acquisition of an ADPS. In most cases, however, the entire office is affected by the installation of ADPS and the scope of the applications encompasses all major divisions. This may require an entirely new type of organization.

If, for example, 75% of the total work effort of an office is being performed by ADPS, why should not the office be organized to permit the most efficient flow of information into and out of the computer? Some people have said this would mean that the people would end up working for the computer. On the contrary, it would mean that the activity have placed the needed emphasis where the work is being accomplished. Effective utilization of ADPS has the effect of forcing functional divisions together. As automatic systems are developed, the functional divisions may be forced into one group handling exceptions and feedback information to management.

Human Relations

Human relations is one of the most difficult problems facing management. Most persons approve of ADPS until it affects them personally; then they are against it. Sometimes just a change in status will cause people not to cooperate with the installation of the computer. A surprising number of executives owe their positions to a particular system which they have been

responsible for introducing and administering. If you take out a man's system, what happens to his job? You can hardly expect him to cooperate wholeheartedly in abolishing it.[15]

Management has a responsibility to keep everyone informed as to what is taking place. Also, management would receive better cooperation if it could insure that no one would lose his job or suffer a reduction of pay because of the installation of the computer. When such a drastic change takes place, there should be some system whereby management can carry the excess people until they can be placed in the ultimate organization. The decrease in personnel should be accomplished only through attrition or reassignment in the area. Without this assurance of security, there may never be any personnel savings.

Some companies have tried to resolve the human relations problems by one of the following methods:

1. Using the step-by-step approach
2. Delaying the implementation of desired organizational changes
3. Applying outdated procedures to ADPS in order to eliminate organization changes

All of these methods merely delay the problem which must be faced at a later date. In the meantime, the costs of ADPS may increase considerably due to inefficient applications.

Management can help to alleviate the human relations problem by:

1. Taking an active part in the planning, installation, and decision-making for ADPS

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[15] "A Business Week Special Report on Computers," Business Week, June 21, 1958, p. 9.

2. Keeping everyone informed about what is going to take place (Lack of adequate management plans may give the impression to some people that information which affects them personally is being withheld.)
3. Soliciting help from anyone who has anything constructive to offer. Management should provide appropriate answers to suggestions which cannot be adopted.
4. Recognizing the fact that all human relations problems cannot be avoided.

Conflict is a normal and even desirable aspect of human affairs, and the problem of morale is largely one of channeling conflict into healthy and constructive avenues.[16]

Statistics

Statistics is a management tool which should become more widely used in ADFS. The term statistics is used to refer both to the data and methods employed in the collection, tabulation, analysis, presentation, and interpretation of quantitative data.[17] It is possible to collect, tabulate, analyze, interpret, and present quantitative data by programming the computer to accomplish this task. Statistical information can be obtained from raw material which is being fed into the computer for another purpose, with very little additional expense. Again, this points up the importance of good planning and the ability of management to anticipate its needs in the area of reports.

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[16] John Pfiffner, The Supervision of Personnel: Human Relations in the Management of Men (New York: Prentice-Hall, Inc., 1951), p. 3.

[17] Kermit O. Hanson, Managerial Statistics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1955), p. 2.

Not only does management require statistical data from information going into the machine, but also there is an equally important need for evaluating the output from the machine. Some activities of the government and industry review 100% of the output from the computer. This indicates that they have no faith in what they told the computer to do or that they have failed to change the organization to remove this responsibility from a functional division.

Sampling is the process or technique which should be used in obtaining information for statistical analysis. Many people insist that the only way to achieve accurate results is to analyze the entire population or, in other words, to take a complete count. There are many sources of error in the basic data and a 100% count can be highly erroneous, as well as nearly impossible to achieve. In fact, a sample can sometimes yield more accurate results than a complete count because the sources of error can be controlled more effectively when only a relatively small number of items are to be examined.

Some of the advantages of a sample rather than a count of the entire population are:

1. A sample can be obtained with less effort and expense than would be required for a total count or analysis.
2. Fewer people are required to count a sample, and more time can be spent to insure that the problem is understood. This should result in more consistent decisions.
3. The time would be less to count the sample and analyze the results.
4. A sample may be more accurate.

There are certain factors which must be considered in establishing a sampling technique:

1. The group must be adequately trained in the job.
2. The group should be organizationally separated so that they are not affected by the results.
3. The sampling should be made after the fact, in order not to slow down the mechanized system. If this procedure were not followed, the speed of the process would be reduced to the speed of the manual review.
4. The method of sampling chosen should be the method or combination of methods that will yield a desired degree of precision at minimum cost.

There are certain other technical factors to consider, beyond the scope of this report, such as determining the size of the sample, and how to select a random sample.[18]

General sampling procedure for surveys consists of the following major steps:

1. Planning the survey
2. Preparing the questionnaire or schedule
3. Selecting the sample
4. Conducting the survey
5. Editing and tabulating the data.

Sampling is being used more and more in private industry and in government. The Air Force uses sampling techniques in the following type projects:

1. Quarterly sample survey of military personnel. A wide variety of information covering characteristics and opinions of Air Force personnel is collected.

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[18] cf. Samuel Richmond, Principles of Statistical Analysis (New York: The Ronald Press Co., 1957), Chaps. 7 and 10.

2. Sample survey of Air Force clothing stores. On the basis of pre-test data it was determined that a sample of 35 out of more than 200 stores would yield acceptable reliable clothing size distributions.
3. Sample of fuel consumption rates. This survey was established in January 1955 to develop more accurate fuel consumption rates (by type and model of aircraft) than were previously available.[19]

Sampling is a valuable tool for obtaining data quickly, cheaply, and accurately.

Automatic Systems

The failure of management to develop automatic systems is the primary reason why ADPS has not realized the envisioned savings. In lieu of automatic systems, management, for the most part, has merely placed a manual system on ADPS.

The Department of Defense recognized the value of the automatic systems approach and, therefore, adopted the name Automatic Data Processing Systems rather than Electronic Data Processing Machines. OSD desired to emphasize the words "automatic" and "systems" rather than "electronic" and "machines".[20]

In order to develop the idea of an automatic system in more detail, this approach will be applied to the inventory control application. Management should take the following action:

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[19] Directorate of Statistical Services DCS/Comptroller, Headquarters, United States Air Force, Sampling In a Nutshell, October, 1955, p. 18.

[20] C. A. Phillips, "Problems and Prospects of Data Processing for Defense," Proceedings of the Fifth Annual Computer Applications Symposium, October 29 and 30, 1958, p. 30.

1. The application should be analyzed in terms of the objectives and policies of the company
2. The inventory control application should be considered in conjunction with other applications; because for an efficient and effective operation ADPS should be a fully integrated system
3. The conceptual planning for the application should ignore the present organizational arrangement. Management should think of the application in terms of flow of information.

Once the application is reviewed in this frame of mind, management may make the following discoveries:

1. There is no need for the present day inventory control division with a completely automatic system of inventory control. This should save a considerable number of people and speed up the system
2. There is no need to print out the detailed item information that is printed out in today's ADPS operation. This should save considerable machine time

Perhaps management is not ready for a completely automatic system and desires a modified approach. The only modified approach which should be permitted is to code exception items, which cannot be programmed because of rapidly changing criterion, or for which no criterion is available. These exception items should be a management decision; they cannot be left to the person whose job is affected by the change. Even though different criterion is required for making a decision concerning certain items, these

items can still be handled automatically. The items can be coded so that the machine will recognize that a different set of decision rules should be used in processing these items.

The real personnel savings will result when management can develop the automatic systems approach to the fullest possible extent. The automatic system can never be developed to the point of perfection, but neither is the manual approach perfect. Some people feel that decisions are not too accurate if a standard criterion is applied for categories of items. Actually, the same procedure is used under a manual system. There is no separate formula for each item and most technical decisions concerning the item are matters of judgment. ADPS may not be perfect but it can be efficient and effective through the use of automatic systems.

Management Reports

Management needs various types of reports in order to properly control and analyze the operation of the business. Through the use of ADPS, management can now receive more timely reports, which are more accurate, upon which to base its decisions.

The use of high speed printers further facilitates the ease with which reports may be obtained. High speed printers have been a great improvement in preparing volume reports such as allowance lists for ships; however, in some instances these printers have been used to print out large volumes of information in inventory control applications in order to make manual decisions. Actually the test of efficiency of an inventory control application is not how much has been printed out, but how little. Usually, the less that is printed out the more automatic the system is.

Management must make the decisions as to what reports are to be prepared. The greater the number of reports, the more time and people it takes

to read them, and the greater expense involved. Management should take the following action concerning reports:

1. Insure that all reports prepared are necessary. One management survey indicated that in many companies reports were prepared which were not being used.
2. Use the technique of sampling to reduce the number of reports being prepared or reviewed.
3. Use summary information instead of item reports to provide the necessary management information.
4. Consider reports at the initial implementation of the application, because a considerable savings may be obtained by including the report in the initial programming.
5. Make continuous review of all reports and revise or discontinue reports as appropriate.
6. Insure that the information to be gained from a proposed report is of greater value than the expense and effort required to make the report.
7. Make maximum use of management by exception reports.

CHAPTER V

Summary

ADPS has the potential to revolutionize business. Both government and industry are installing computers in greater numbers each year. The change in management, however, that is taking place is more by evolution than revolution. Changes which were envisioned to occur in from two or three years will probably occur in from eight to ten years. The problem is that management has not kept pace with the technological advancement of computers.

Even though the pace has been slower than anticipated, there have been some important advances in the field of ADPS. Most important of these benefits are:

1. Speed--Most activities have been able to capitalize on the speed of the computer which has resulted in shortening the processing time in various applications. This has permitted savings in inventories, warehouse space, etc.
2. Accuracy--The accuracy of reports has improved greatly through the use of ADPS.
3. Management reports--Most timely reports are now available upon which management can base its decisions.
4. Personnel savings--Some savings of personnel have been realized, although not as great as anticipated.

5. Management technique--Some activities have employed management by exception techniques, thereby permitting management to spend its time where emphasis is needed.

The real potential of ADPS is yet to be realized, and management holds the key to this available wealth. The potential of ADPS can be reached only if management has the ability to use it. In other words, in order to have an efficient and effective computer installation and operation, a company must first have an efficient and effective management.

There is little doubt that most activities and companies should scale down their expected benefits from ADPS. Now the new theme is: "We are not saving anything but we are doing so much more." This appears to be a good scrapegoat for lack of management. Some of the main reasons for failure of activities to accomplish their expected savings are:

1. Lack of management participation--The job of installing and planning for the computer is usually left to a committee which does not have the authority or cooperation required for the assigned task.
2. Failure of management to provide guidelines and objectives on what is to be accomplished.
3. Failure of management to be trained on how to use the computer effectively--For example, the development of automatic systems to the maximum extent possible.
4. Failure to reorganize concurrently--With the advent of tools which are so radically different, a new organization is required in order to use these tools effectively.

5. Failure to use management sciences--Operations research and sampling techniques could be used to a greater advantage.

6. Failure of agencies to restrict pilot-outs--In some cases information is carried out to make better manual decisions when the decisions could have been made automatically by programming.

[illegible] the Bureau of the Budget and the General Accounting Office are [illegible] are interested in the operation of the many computers in government. The governmental systems involved in the creation of data will probably require activities to be subjected to greater controls in the future. The earlier all activities can put [illegible] on a routine basis, the less need there will be for extensive controls.

Teamwork can improve the operation of ADP and possibly provide an overall monetary savings. Any type of computer can be used to an advantage, provided the applications are suitable for ADP.

One of the causes for failure to accomplish the estimated savings can be attributed to technical problems. The computer business is very competitive and on a competitive bid basis each manufacturer submits his estimates of processing time on an optimum basis. Unfortunately these estimates are of little value except for comparison of machines. A safety factor of perhaps 25 to 50% should be added to more closely arrive at the expected processing time and costs. Also, programming and testing of applications have consumed more time than was anticipated. This does not mean that programming talent is not available. There are adequate testing standards which are suitable for selecting personnel who have an aptitude for such detailed work, and most activities have been successful in recruiting the type of person required.

Another problem which increases processing time is applications which exceed memory capacity in programming. Sometimes the manufacturer will indicate that a job can be programmed for one pass through the computer. There is no method of disproving this assumption until the job is actually programmed. If the raw material or source data must be passed through the machine a second time, the processing time may be almost doubled.

Recommendations

Companies will undoubtedly improve their operation of ADPS as they gain by experience. The difficulty with this method is that progress is made by evolution rather than revolution. Improvements which could be made in a few years are put off for many years. There is one advantage to the evolution approach and that is that the entire organization may not be upset at the same time. It makes the human relations problem easier.

The restrictive budget demands that the improvements be accomplished as quickly as possible. The following recommendations will assist management in achieving this goal:

1. Management must take an active part in the planning and preparation for installing ADPS. The decisions to be made during this period require constant management participation.
2. Management should establish definite goals and objectives to be accomplished through the use of ADPS. Also, there should be schedules for accomplishing these goals.
3. Automatic systems should be used to the maximum extent possible. Deviations from automatic systems should be approved by management. A person whose job is affected by ADPS cannot be expected to cooperate in abolishing his job.

4. Concurrent reorganization must take place with the framework of planning for ADP. There must be some way to insure that no individual will lose his job or status because of ADP. The required changes should be made through reassignment or attrition; otherwise, cooperation will be minimized and savings may disappear. Each individual should be aware of his status at all times.

5. Operations research techniques should be used as much as possible. Various sampling techniques can reduce to the minimum any manual review required. As management becomes more sophisticated and mathematical formulas become more widely used, any manual review after processing should be reduced to a minimum. The persons performing manual review would not have the mathematical intelligence required to reject the results on a logical basis. A wasteful process would occur if a highly skilled mathematician developed a formula which management across should predominate other decisions, and then have a person of lesser ability reject the results because he is organizationally responsible.

6. Management by exception techniques should be employed wherever possible. Management can establish the ground rules for the conditions under which a report should be prepared. Management should insure that every report serves a useful purpose and that it is discontinued or revised when appropriate. Management should insure that

the benefits gained from a report exceed the cost and effort required to prepare it.

7. Management should receive training on how to use ADPS efficiently. Anyone who has any control over the computer or control over the applications being processed should be well versed in the cost and limitations of the computer. Some jobs that have been placed on a computer can be accomplished more efficiently on a manual basis.
8. In the review process established by OSD greater emphasis should be placed on the means of accomplishment rather than the expected savings. The means of accomplishment is management. During the review process, the activity should be questioned concerning the automatic systems approach. For example, in an inventory control application what percent of the items will be handled automatically and what percent will be reviewed manually? What sampling techniques are used and what organizational element performs the review? Various other questions could be pointed to the automatic systems approach. Also, there must be some way to insure that management is taking an active part in the process. What statement of objectives have been published and are they being followed?

The Future of ADPS

The technological advancements in computers will continue. Already solid state computers are taking over the field. These computers will allow a considerable reduction in installation costs. Less air conditioning

will be required, and space requirements will be less as the computers become more compact.

Various programming techniques are being developed and some are in use which will simplify programming. This should reduce programming time as well as save valuable memory space in the computer. A universal computer language moved one step closer to reality with the announcement of COBOL [Common Business Orientated Language].[21] This is a new source language system which will permit programmers to use English words, statements, sentences, and paragraphs in communicating instructions to the computer system. This new language which is expected to be common to almost all makes and models of computers will make ADPS more compatible between different systems. One computer manufacturer has already announced that his new computer will use COBOL.

If management's techniques have failed to keep pace with technological advancements in the past, how will management keep pace in the future? These improvements in programming techniques should assist management and, therefore, should help to improve management techniques. Changes to the applications should be accomplished more easily.

The responsibility for improvement in management should not be the responsibility of the manufacturers, although they have offered and do give valuable assistance. The customer should not expect the person who benefits from customer mistakes to help him. The manufacturer should provide ample technical assistance and training, but management is a local problem or a problem for the regular chain of command.

The future should reveal significant improvement in management of ADPS. Management sciences should be used to greater advantages and automatic

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[21] Robert W. Bemer, "COBOL--Common Language for Computers," Management and Business Automation, March, 1960, p. 22.

systems will become of age. Under this approach greater emphasis will be placed on the problem before it goes into the computer, and there will be very little after-the-fact manual processing or review.

One computer user has stated that computers are like grand pianos—you can become a virtuoso, or you can play Chopsticks all your life.[22] Whatever tune is played is decided by management.

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[22]"A Business Week Special Report on Computers," Business Week, June 21, 1958, p. 8.

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